to make strategic use of arrows to represent temporal relations, leaving both dimensions free to represent the mechanism's spatial or similarity relations. Another solution is to use techniques for projecting three dimensions onto a two-dimensional plane.

Whether the temporal order of operations is represented by means of a spatial dimension or by arrows, a diagram has clear advantages over linguistic description. The most obvious advantage – that all parts and operations are available for inspection simultaneously – probably is the weakest one. Due to processing limitations, people can take in only one or a few parts of the diagram at a time. Nonetheless, more so than when reading text, they have the freedom to move around it in any number of ways; and as the diagram becomes more familiar, more of it can be taken in at one time. A stronger advantage is that diagrams offer relatively direct, iconic resources for representation that can be invaluable. For example, it is immediately apparent in the heart diagram that blood is being pumped simultaneously from the two atrial chambers to the two ventricles and that these two parallel operations are in a sequential relationship to two other parallel operations (pumping from the two ventricular chambers).

The value of consulting a diagram in this way is even more apparent in mechanisms with feedback loops, through which an operation that is conceptually downstream (closer to producing what is taken to be the product of the mechanism) has effects that alter the execution of operations earlier in the stream at subsequent time steps. Multiple examples can be found within the cellular respiration. As biochemists discovered in the 1930s, it is composed of three connected submechanisms (as illustrated in the next chapter in Figure 3.16). When these are further unpacked, they are seen to involve coordinated biochemical operations, including feedback operations. Figure 2.3 shows an important feedback loop that operates at the interface between the first two submechanisms – glycolysis and the citric acid cycle. The diagram aids understanding by spatially laying out the parts of the system (compounds such as pyruvate) and by using the vertical dimension as well as arrows to indicate the sequence of operations (solid arrows for the reactions and a dotted arrow for the feedback loop).

An important principle recognized by cognitive scientists engaged in modeling reasoning computationally is that it is essential to coordinate the modes of representation and procedures of inference. If diagrams are an important vehicle for representing mechanisms, then it is necessary to consider how people reason about diagrams. Philosophers since Aristotle have often assumed that procedures of logic, especially natural deduction, describe our reasoning. But logic operates only on linguistic representations, so if scientists reason